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Mapping Ni pollution in SarkhounPlain (Bandar-e-Abbas), using Geostatistics Techniques

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Abstract. Industrial activities are considered as sources of cities and agricultural areaspollution. Sarkhoun Plain as an agricultural area, in the vicinity of Sarkhoun Gas Refinery, is vulnerable to soil pollution. This study arranged to evaluate and survey Nickel pollution state in this plain. In a systematic soil sampling,120 compound topsoil samples were gathered out of a 100 km^2 field. Total soil Ni concentration was measured by Atomic Absorption Spectrophotometer after digestion of soil samples in 4normal Nitrik acid. Spatial variation of Nickel concentration mapped using ordinary kriging. The results indicate possible impacts of Gas Refinery on soil pollution by Ni.

Keywords: Mapping, Nickel, Sarkhoun Plain, Geostatistics, pollution.

1. Introduction

In the health and environmental view, geographical advances have a sudden impact on environment and human health. Every day, human activities like urban, industrial, commercial, and agricultural activities, leave pollutions in the environment. Urban discharges and heavy elements comprise the biggest portion of pollution (Nariagu and Pacyna 1988). Refineries, mines, and fertilizers (exclusively phosphate) are the most important sources of Nickel dispersion in soil (McGrath 1995).The averageamount of Nickel should be 40 milligrams in one kilogram of soil (European Environment Agency1999). The most common effect of Nickel on human's body is a biological reaction resulting skin irritation, Lung cancer, nasopharynx cancer, larynx cancer, andprostate cancer. Also, pulmonary diseases like chronic bronchitis and pulmonary function disorder were seen among the workers who had breathed in air with high dosage of Nickel (Moody et al. 2009).

Geostatistic has been become a very useful device for training and forecastinglocal changes in earth-referenced variables, and during the recent two decades, it has shown a great performance in soil science (Krasilinikov et al. 2008). This science is applied for forecasting and mapping soil in sampled fields. Among the Geostatistic techniques, kriging is the best non-diagonal estimator for quantity and also, it provides the possibility of using sampled points to estimate not sampled ones by applying spatial correlation of forecastedsample points, and reducing the estimation error variance to the minimum, and alsothe technique has the ability to estimate the values in not sampled points with high accuracy.

During a study on heavy elements, carried out in Italy, Daniel and his teammates found that the pollution made by mercury, copper, lead, and zinc are the results of human activities and Vanadium, Manganese, Nickel, Cobalt, Chromium, and Cadmium pollutions come from parental materials of the area (2002).

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Having prepared the local pollution maps by GIS and Geostatistic techniques, they showed that vehicles are the major source of pollution. This survey is aimed to use Geostatisitc techniques in mapping Nickel pollution of Sarkhoun plain which is located at north of Bandar-e-Abbas.

2. Materials and Methods

The studied area, a space of 100 km^2 extent, is located at north of Bandar-e-Abbas (Iran). Sarkhoun Plain is located between 27° 23' to 27° 27' Northern Latitudes and 56° 19' to 56° 28' Eastern Longitude (Fig.1). The major applications of the area are agricultural and industrial uses. In a systematic soil sampling, 120 compound top soil samples (0-10 cm) were collected with approximately 900 meters as the distance between each two points. Geographical position of the sampling points had been specified on a map with 1:25000 scale before re-indicatingsampling points by Global Positioning System (GPS). Total soil Ni concentration was measured by Atomic Absorption Spectrophotometer after digestion of soil samples in4noraml Nitric acid (Sposito et al. 1982). Statistical description of data was carried out by using STATISTICA 8.0 software.

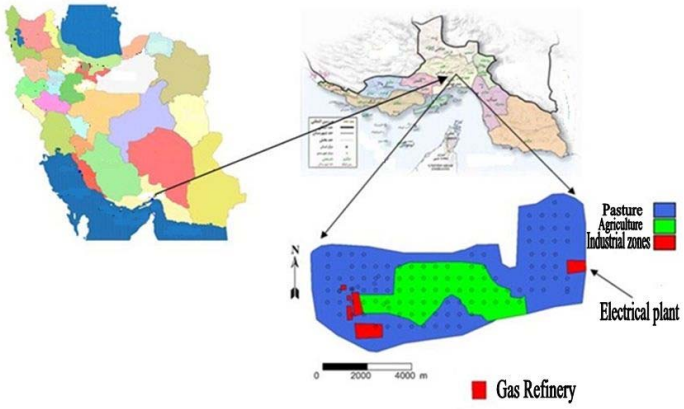

Fig. 1: Location of study area.

The main application of geostatistics in soil science is to estimate and soil attributes in not sampled areas (Goovaerts 1999). This method uses the semi-variogram to quantify the spatial variation of a regionalized variable. The semi-variogram,$\boldsymbol{\gamma(h)}$, measures the mean variability between two points x and x + h, as a function of their distance h.

$$\gamma(h) = \frac{1}{2N(h)} \sum_{i=1}^{N(h)} (Z(x_i) - Z(x_i + h))^2$$

Z (Xi) is the value of the variable Z at location xi, and N (h) is the number of pairs of sample points separated by the lag distance h. The geostatistical analysis was carried out using VARIOWIN 2.0 (version 2.0). Based on the fitted semi-variogram models, the ordinary Kriging provided by the software SURFER (version 9.0) and also itwas used to map the distribution of heavy elements.

3. Conclusion

3.1. Statistical Summary

Table 1 shows a summary of descriptive statistics of Nickel concentration. Topsoil samples show a range between 24.3 to 51.52 milligrams of Nickel in 1 kilogram of soil. The maximum Nickel concentration in the samples is higher than European Environmental Agency's standard (European Environmental Agency 1999). This agency has defined the threshold of Nickel in soil as 35 mg/kg.

Table 1: The Summary of Nickel concentration statistics in topsoil.

Soil property	Mean	Median	Min	Max	S.D.	CV (%)
Ni	31.96	33.30	3.24	52.51	10.69	33.47

CV: coefficient variation S.D.: standard deviation

3.2. Spatial Distribution

The Ni was best fitted to the Exponential model (Fig. 2).

Table 2: Best fitted semi-variogram models of Nickel.

Soil properties	Model	Nugget	Sill	Range/km
Total Ni	Exponential	50.03	109.36	4924

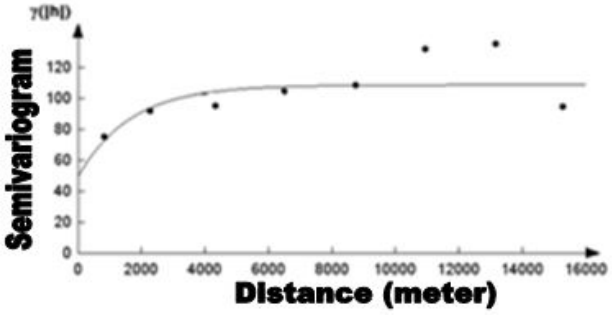

Fig. 2: presents the semi-variogram and fitted model for total Ni.

Ordinary kriging was used for perception of Nickel spatial distribution. Figure 3 shows the presence of Nickel in densities more than 40 mg/kg, in south eastern part of the area where is the nearest to the refinery of Sarkhoun Plain. Likewise, the rates of spatial correlation is 45% and high coefficient of variation for total Nickel in soil indicates the effect of human factor on the density of this element. Therefore, the refinery is considered as a potential source of pollution. Figure 3 shows pollution assessment of Nickel. The highest variance estimation can be seen in the margins of the areas and spaces among sampling points, due tolow number of sampling points in these places.

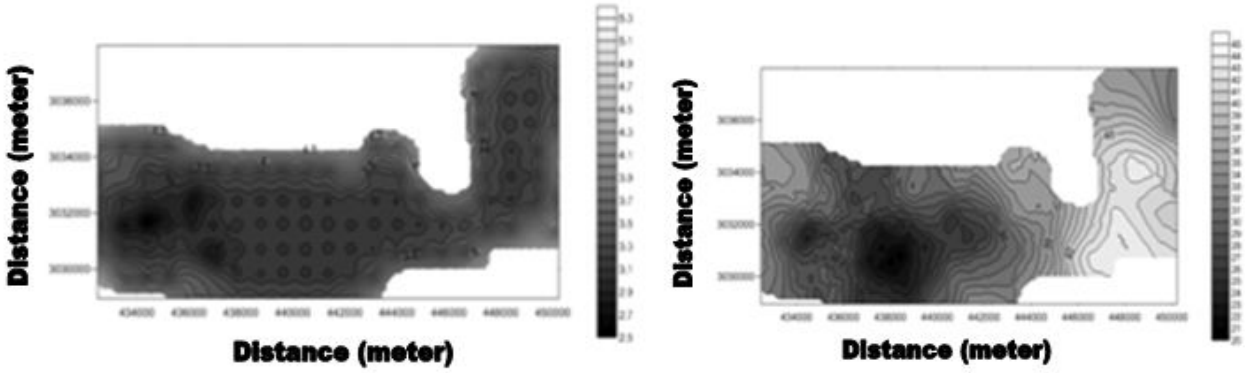

Fig. 3: Ni concentration spatial distribution maps.

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